TRIPP·LITE
POWER PROTECTION

www.tripplite.com

Practical Power Guidelines for VoIP and Internet Telephony Applications

by David Slotten

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WHITE PAPER

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Integrate Backup Power into VoIP Networks

Voice over IP (VoIP) is exploding in popularity as an application for business data networks. VoIP promises to consolidate a company's data and telecommunications infrastructure as well as its support resources. As a result, a company can lower its hardware and service costs while raising productivity through the use of more elaborate and customizable telephony applications.

Unfortunately, there are serious limitations inherent to the data networks that are increasingly called upon to support VoIP. The primary limitation is power availability. Before moving voice traffic from traditional circuit-switched public phone systems to private data network connections, one must consider a public phone system's unique attribute—battery support. In order to deliver extremely high availability for such vital services as emergency 911 support in the event of extended power outages, public phone systems are connected to massive battery arrays.

While most data networks have some type of backup support during power outages (provided by UPS Systems and/or generators), the backup runtime is generally much less than the 4 to 8 hours of backup that is typically provided for public phone systems. Because of this shortcoming, VoIP applications generally require an increase in the UPS System-supported power capacity (e.g. more or larger UPS Systems). Increased UPS System capacity provides power for network-dependent phones and increases overall backup runtime to ensure that normal telephone operation (including 911 service) remains available in the event of an extended power outage.

Reflecting on important lessons learned during its own transition to IP telephony, Cisco provides several best-practice recommendations. One of the most important recommendations is installing a UPS System to guarantee availability:

"Plan Your Power: When an IP network carries voice, reliability is essential. In case of an emergency, people need to summon assistance by dialing 911. When using inline power to switches and routers, make sure they are connected to an uninterruptible power supply [UPS System] to guarantee dial tone if the power should go out."

Source: Cisco Systems white paper "The Transition to IP Telephony at Cisco Systems".

http://www.cisco.com/en/US/tech/tk652/tk701/technologies_white_paper09186a00800cb7fd.shtml

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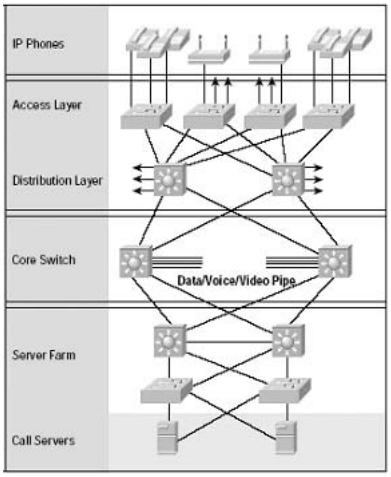
Consider the Diverse Needs of VoIP Network Equipment

Before selecting a UPS System to ensure 100% availability of IP telephony systems, it's important to consider the unique requirements of VoIP network equipment. Network designs hosting VoIP applications will vary widely from business to business due to a number of variables, including the scale of the network and the variety of legacy equipment involved. However, three devices are common to all networks:

Typical VoIP Network Design



Source: Cisco Systems white paper "Power and Cooling for VoIP and IP Telephony Applications".

http://www.cisco.com/application/pdf/en/us/guest/netsol/ns412/c654/cdccont_0900aecd801a2c5f.pdf

Client Devices (phones, PC-based soft phones, etc.)
During the transition to IP telephony, these devices will either (a) derive their power from the network cable via a Power over Ethernet (PoE) connection scheme, or (b) plug into a local AC source.

If they plug into a local AC source, they must be protected by a UPS System. Often a desktop UPS not only safeguards phone service, but also guarantees file integrity for associated PC users.

Networking Devices (switches, routers, etc.)
During the transition to IP telephony, port capacity on the network and in wiring closets will increase to accommodate additional devices (phones) connected to the network. Increased port capacity will increase the power requirements placed on your UPS System, either reducing runtime or overloading the UPS. Note that if a networking device also supplies Power over Ethernet, the aggregate load of all client devices will also be borne by the networking device's UPS System.

Generally, an existing UPS will be inadequate to (a) power the increased load [watts] and (b) power the load for an acceptable length of time. Five to fifteen minutes of runtime provided to gracefully shut down the typical data network is inadequate for IP telephony users who expect phone service to continue for HOURS, not minutes.

Call Processing Devices (servers and related storage systems)
During the transition to IP telephony, dedicated servers are typically added to drive voice and messaging applications, while storage systems are required for voicemail and other messaging applications. Similar to the increased burden placed on networking devices, call processing devices will experience increased loads and will require increased runtime.

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Select a UPS System which Provides the Highest Availability, Resiliency and Manageability

When selecting a UPS System, the most obvious criterion to consider is whether a UPS System has enough capacity (VA/watts) to power equipment while having enough battery capacity to operate during a power outage for your required duration. Specific Tripp Lite UPS System recommendations are listed at the end of this document. Often overlooked during the selection process, however, are more subtle, yet critical, criteria that should be considered, including availability, resiliency to power anomalies and manageability.

1. Availability

Availability hinges on three considerations: the VoIP equipment's power supply configuration, the UPS System's battery configuration and the UPS System's power electronics topology.

A. VoIP Equipment Power Supply Configuration

Many switches and routers are equipped with redundant power supply capability. If one power supply fails, a second power supply steps in and powers the device. Redundant power supply configurations are strongly recommended to ensure continuous system availability.

Whether one or two power supplies are deployed, the equipment can draw power from one of three sources: directly from facility power alone (for simplicity's sake we will use the term “wall” to describe this source), from a single UPS System or from multiple UPS Systems.

The following tables detail a switch's operational status, from a power perspective, in both redundant and combined (non-redundant) modes. The tables detail switch status under a variety of operational scenarios, including power supply failure, utility failure and UPS System failure.

Note: Larger switches often have the capability to be alternatively configured to operate in a combined (non-redundant) configuration. In combined mode, two power supplies' capacities will be summed. A true doubling is not generally achieved. A factor of 1.67x is typical. In combined mode, there is no redundancy. Should a power supply fail, the available power is generally reduced to the capacity of a single power supply.

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Single Power Supply, or Multiple Power Supplies Operating in Redundant Mode

STEP 1: Determine Configuration								
Configuration	1	2		3		4	5	
Power Supply	PS1	PS1	PS2	PS1	PS2	PS1 & PS2	PS1	PS2
Power Source	Wall	Wall	Wall	UPS1	Wall	UPS1	UPS1	UPS2

STEP 2: Consider Failure Scenarios			STEP 3: Consider System Status				
PS1 Status	Utility Status	UPS Status	System Status	System Status	System Status	System Status	System Status
OK	OK	OK	OK	OK	OK	OK	OK
Failure	OK	OK	Crash	OK	OK	Crash	OK
OK	Blackout	OK	Crash	Crash	OK	OK	OK
OK	Blackout	UPS1 Battery Fails	Crash	Crash	Crash	Crash	OK
OK	Blackout	UPS1 Internal Fault	Crash	Crash	Crash	Crash	OK
OK	OK	UPS1 Battery Fails	—	—	OK Hot swap battery	OK Hot swap battery	OK Hot swap battery
OK	OK	UPS1 Internal Fault	—	—	**Line-Interactive UPS Systems**		
					OK Replace UPS. System on PS2/Wall. Vulnerable to outage during UPS replacement	Crash Replace UPS.	OK Replace UPS. System on PS2/UPS2. Services OK during UPS replacement
					On-Line UPS Systems		
					OK UPS on bypass, System on PS2/Wall. Replace UPS1. Vulnerable to outage during UPS replacement	OK UPS on bypass. System on Wall. Services down* while replacing UPS1	OK UPS on bypass, System on PS2/UPS2. Replace UPS1. Services OK during UPS replacement

*SmartOnline Hot-Swappable Modular 5-16KVA UPS system hardware can be hot swapped without service outage.

Multiple Power Supplies Operating in Dual (Combined, Non-Redundant) Mode

STEP 1: Determine Configuration					
Configuration	1		2	3	
Power Supply	PS1	PS2	PS1 PS2	PS1	PS2
Power Source	Wall	Wall	UPS1	UPS1	UPS2

STEP 2: Consider Failure Scenarios			STEP 3: Consider System Status		
PS1 Status	Utility Status	UPS Status	System Status	System Status	System Status
OK	OK	OK	OK	OK	OK
Failure	OK	OK	Reduced Output	OK	OK
OK	Blackout	OK	Crash	OK	OK
OK	Blackout	UPS1 Battery Fails	Crash	Crash Replace UPS1. Output reduced during UPS replacement	Reduced Output Replace UPS1. Output reduced during UPS replacement
OK	Blackout	UPS1 Internal Fault	—	Crash Replace UPS1	Reduced Output Replace UPS1. Output reduced until UPS1 replacement
OK	OK	UPS1 Battery Fails	—	OK Hot swap battery	OK Hot swap battery
OK	OK	UPS1 Internal Fault	—	**Line-Interactive UPS Systems**	
				Crash Replace UPS. Plug into wall until UPS replacement	Reduced Output Replace UPS1. Plug PS1 into wall to restore full power until UPS1 replacement. Output reduced until UPS1 replacement
				On-Line UPS Systems	
				OK Replace UPS1. Both PS on UPS Bypass. Services down* while replacing UPS1	OK Replace UPS1. PS1 on UPS1 Bypass circuit, vulnerable to outage. Reduced power during UPS1 replacement

*SmartOnline Hot-Swappable Modular 5-16KVA UPS system hardware can be hot swapped without service outage.

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B. UPS System Battery Configuration

UPS System availability, and therefore VoIP system availability, is most critically dependent upon the capacity of the UPS System's battery configuration. The number of UPS System batteries, both internal and external, determines the amount of runtime that is provided during a power outage. As mentioned previously, the runtime must fit the application. Most existing data networks are unlikely to provide reserve runtime power comparable to the public switched phone network. One has to determine a runtime estimate of what is adequate or desirable specifically for a VoIP application. Most users conclude that hours, not minutes, of backup runtime are required to maintain voice operations.

Like any estimate, a runtime estimate will be imperfect and will also be impacted by future capacity requirements (such as the addition of more phones). Therefore, it is critical that the selected UPS System can accommodate external battery packs to increase runtime as needs increase, or maintain runtime in a growing phone environment.

Runtime scalability with external battery packs also yields the ability to hot swap battery packs at the end of their useful life without a service interruption. Similar hot swap battery replacement is also the norm for the UPS System's internal batteries.

C. UPS System Power Electronics

If a UPS System's power electronics fail during a utility power outage, the supported IP telephony system will obviously crash. If the UPS System failure occurs while utility power is present, however, different UPS power electronics topologies can impact IP telephony system availability in different ways.

On-Line UPS System with Internal Bypass

With power present, an internal power electronics fault in an on-line UPS System will result in the load automatically being powered by a bypass path inside the UPS. As long as utility power remains present, the UPS will continue to power the connected IP telephony system without interruption and will continue to condition the power against basic power anomalies. In the event of a power outage, the system will crash.

Upon development of a bypass condition, a service interruption needs to be planned to replace the UPS System.

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With power present, a battery system failure will not cause a system interruption. As long as utility power remains present, the UPS System will continue to power the connected IP telephony system without interruption and will continue to condition the power against most power anomalies. In the event of a power outage, the system will crash.

In the event of a battery system failure, the internal batteries of the UPS System and/or the external battery packs can be replaced without a service interruption.

On-Line UPS System with Internal Bypass and External Maintenance Bypass

With power present, an internal power electronics fault will result in the load automatically being powered by a bypass path inside the UPS. As long as utility power remains present, the UPS will continue to power the connected VoIP system without interruption and will continue to condition the power against basic power anomalies. In the event of a power outage, the system will crash.

In the event of a bypass condition, the power electronics module of the UPS should be replaced. This can be performed while the system remains in service, as the input and output power connections are physically and electrically separated from the power module itself. This functionality is available presently in Tripp Lite's 5-16KVA SmartOnline™ Hot-Swappable Modular UPS Systems.

With power present, a battery system failure will not cause a system interruption. As long as utility power remains present, the UPS System will continue to power the connected IP telephony system without interruption and will continue to condition the power against most power anomalies. In the event of a power outage, the system will crash.

In the event of a battery system failure, the internal batteries of the UPS System and/or the external battery packs can be replaced without a service interruption.

Line-Interactive UPS System

With power present, an internal power electronics fault can result in the load crashing. As the operational requirements of a line-interactive UPS System are very simple when power is present, this is extremely rare. Line-interactive power electronics failures are normally only detected when the power fails and the UPS attempts to power the load from its battery-driven inverter.

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In the event of a power electronics failure, a service interruption needs to be planned to replace the UPS System.

With power present, a battery system failure will not cause a system interruption. As long as utility power remains present, the UPS System will continue to power the connected IP telephony system without interruption and will continue to condition the power against many power anomalies. In the event of a power outage, the system will crash.

In the event of a battery system failure, the internal batteries of the UPS System and/or the external battery packs can be replaced without a service interruption.

2. Resiliency to Power Anomalies

The fundamental outcome one hopes for in adding UPS System support to a network is to enhance system availability. But an additional concept—resiliency—is very important as well. UPS System resiliency reflects the ability to respond positively to a number of operating variables.

A. Voltage Variation

Currently, one of the most popular UPS System topologies for VoIP is provided by on-line UPS Systems. An on-line UPS System can deliver perfect power even if it encounters a very wide range of input voltages. The on-line UPS does this without relying on its battery reserves, leaving it well prepared to respond to a power outage. Because of its continuous AC-DC-AC conversion process, during an outage an on-line UPS System will also exhibit zero transfer time between power failure detection and power delivery to your equipment. On-line UPS Systems are widely acknowledged to be compatible with all types of VoIP devices.

In many networks with distributed UPS Systems, line-interactive UPS Systems are widely deployed. If input voltage levels are below the line-interactive UPS System's automatic correction capability, the UPS will switch to battery to maintain acceptable output voltage. In areas with chronic extreme brownouts, this frequent switching to battery can reduce reserve power as well as shorten battery service life—putting critical systems at risk in an outage.

While the transfer time of a line-interactive UPS System (several milliseconds) is extremely fast, this short delay has been theorized as the cause of packet losses, or even system shutdown in some applications. Depending on your power environment and the sensitivity of your IP telephony components, a line-interactive UPS System may or may not be

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adequate. Generally, line-interactive UPS Systems do not pose a problem. This is the subject of some debate and is generally presented as a major issue by vendors biased towards selling online UPS Systems.

Line-interactive UPS Systems do tend to cost less than on-line UPS Systems and operate with higher efficiency, reducing electrical costs.

In theory, an on-line UPS System battery should be used less frequently due to input voltage variation, and will therefore last longer. This advantage will manifest itself more as the frequency of input voltage variation increases.

B. Harmonic Distortion

Only an on-line UPS System will address input harmonic distortion. Because an on-line UPS System deconstructs and reconstructs the input power, it can deliver distortion-free power. A line-interactive UPS System will pass through input waveform distortions. Harmonic distortion tends to be an elusive "gremlin" issue when it affects connected loads.

C. Transient Spikes (or "Surges")

Both line-interactive and on-line UPS Systems address sudden increases in voltage.

D. Electromagnetic Interference

While both line-interactive and on-line UPS Systems address these phenomena, an on-line UPS typically offers far superior filtering capability.

3. Manageability

VoIP system availability is closely tied to UPS System manageability. To ensure continuous availability, UPS Systems must be incorporated as an integral part of a sound hardware management scheme. UPS Systems are extremely manageable and responsive, communicating their status automatically and triggering application shutdowns prior to battery exhaustion in the event of a power outage or extreme voltage variation.

There are various methods to communicate with UPS systems, including SNMP, Web, network software and direct connection. While most users choose SNMP/Web accessory cards installed inside UPS Systems for communication, the most essential requirement is to deploy and use some method of communication. Without a management application running for your UPS Systems, the day will come when the UPS batteries fail and your system fails as your power fails. Simple management steps taken at installation can save significant problems later.

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Alerts available from most UPS Systems and network cards include:

- Voltage levels
- Current levels
- Temperature levels
- Humidity levels
- Dry contacts for fire, water, security, etc.
- Battery capacity
- Battery failure

Commands from the administrator to most UPS Systems include:

- Reboot system
- Reboot outlet(s)
- Shut down system
- Shut down outlet(s)
- Run inverter/battery test

Tripp Lite presents a uniquely simple management scheme for VoIP UPS System hardware. Whether management is through an IP-addressed SNMP/Web accessory card or PowerAlert Software, Tripp Lite provides administrators with a single JAVA-based user interface. The commonality within this design approach makes it ideal for managing VoIP applications of all scales across multiple OS platforms.

During a power failure, Tripp Lite's PowerAlert Software ensures a smooth and customizable shutdown of call processing and voice messaging applications as well as the underlying operating system.

As a unique feature, Tripp Lite's PowerAlert Software and network accessory card (SNMPWEBCARD) are designed to accommodate multiple power supply and UPS System hardware deployments. With a single IP address assigned to the SNMPWEBCARD (or a single PC/Server running PowerAlert) users can manage multiple redundant UPS Systems working in tandem to provide optimal power to the IP telephony system's single or multiple power supplies.

Alternative UPS System manufacturers require each UPS to be managed individually. With these UPS Systems, there is no easy way to manage their redundant operation without expensive and space-consuming external power-switching accessories.

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Tripp Lite's PowerAlert Software, version 12.5—which is part of an integrated VoIP power solution that includes a Tripp Lite UPS System—has met the Cisco Technology Developer Partner Program test criteria for interoperability with Media Convergence Servers running CallManager, versions 3.3(4) and 4.0(2). Through participation in the Cisco Technology Developer Partner Program, Tripp Lite's integrated VoIP solution provides continuous IP telephony availability to enterprise customers.

As an additional management tool, PowerAlert also offers centralized management within a NMS-style, management tool.

Another unique manageability product provided by Tripp Lite is its Watchdog Service Monitoring/Rebooting Software. Tripp Lite's Watchdog Software ensures maximum availability, eliminating call processing server downtime by automatically rebooting locked-up or poorly performing system service applications. If a locked service cannot be rebooted, Watchdog Software will automatically direct PowerAlert Software to reboot the server. If the server is non-responsive, the UPS System will power down and then restart the attached devices.

Recommended Tripp Lite UPS Systems for VoIP Applications

Establishing an adequate power protection infrastructure is essential. Again, three areas of demand must be addressed: Client, Network and Call Processing.

Client Devices (phones, PC-based soft phones, etc.)

- *IP Phones*

  If the phone is powered by Ethernet (PoE), it is switch supported and no client UPS System is required. (Backup will be provided at the switch.)

  If the phone plugs into the utility wall outlet, a UPS System is required.
  - Up to 4 hours - Tripp Lite UPS model: INTERNET750U

- *Soft Phones (PC based)*

  Typically, a UPS System is required:
  - Up to 1 hour - Tripp Lite UPS model: OMNIVS1500XL
  - Up to 3 hours - Tripp Lite UPS model: OMNIVS1500XL (Plus Tripp Lite battery pack model: BP24V28-2U
- *Soft Phones (Notebook PC based)*
  - Up to 2 hours - internal notebook battery support
  - Up to 4 hours - Tripp Lite UPS model: INTERNET750U

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Networking Devices (switches, routers, etc.)

Networking hardware will typically drive the most significant changes to your existing power infrastructure. With requirements spanning buildings and remote wiring closets, existing facility-wide backup plans are often impractical or unable to address the requirements of mid-size and large switches. Focused UPS System additions with extended runtime battery configurations more efficiently add the high level of availability that VoIP users demand.

Tripp Lite maintains interactive sizing and configuration resources at www.tripplite.com/selector. We also welcome your contact with our technical staff via techsupport@tripplite.com or (773) 869-1234.

Basic sizing is as simple as…

1. Determining the power consumption of your equipment:
   Volts x Amps = VA.
2. Ensuring that the UPS System has enough power and outlets to accommodate your equipment.

Many larger routers and switches accommodate multiple power supplies. Once you have identified your power supply type and quantity, use the following details to find a specific UPS System solution for your needs:

1. Identify power supply configuration
   a. Single power supply or two supplies operating in redundant mode
   b. Dual (combined) mode
2. Determine UPS System protection scheme
   a. Single UPS System for both power supplies
   b. Single UPS System per power supply (higher availability)
3. Estimate desired runtime during power outage

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Call Processing Devices (servers and related storage systems)

Typically, additional server and storage resources are added to handle call processing, voice messaging and other telephony applications. Such systems tend to reside within the data center and are multi-vendor in origin.

For configuration assistance specific to your rollout, please contact Tripp Lite. Tripp Lite maintains interactive sizing and configuration resources at www.tripplite.com/selector. We also welcome your contact with our technical staff via techsupport@tripplite.com or (773) 869-1234.

Common Tripp Lite UPS Systems Recommended for VoIP Networking Device Applications (Specifications & Runtime Charts)

UPS System Specifications									
Model	Input Voltage Range	Nominal Output Voltage	Capacity (VA/Watts)	Outlet Quantity	Outlet Type	Input Plug Type	RU	Depth	Bypass
SmartOnline On-Line UPS Systems									
SU2200RTXL2Ua	65-138	120 (110/120)	2200/1600	7	6 (5-20R) 1 (L5-20R)	5-20P	2U	19 in.	Internal
SU3000RTXL3U	65-138	120 (110/120)	3000/2400	9	4 (5-15R) 4 (5-20R) 1 (L5-30R)	5-20P	3U	26 in.	Internal
SU3000RTXL3UHV	160-275	208/240	3000/2400	8	6 (6-20R) 2 (L6-20R)	L6-20P	3U	21 in.	Internal
SU5000RT3U	156-276	208 & 120	5000/3500	16	2 (L6-20R) 2 (L6-30R) 12 (5-20R)	L6-30P	7U	21 in.	Internal
SU5000RT3UHV	156-276	208/240	5000/3500	4	2 (L6-20R) 2 (L6-30R)	L6-30P	5U	21 in.	Internal
SU5000RT4U	65-140 (L-N)	208/240 & 120	5000/3800	12	8 (5-15/20R) 2 (L6-20R) 2 (L6-30R)	L14-30P	4U	30.75 in.	Internal/External
SU6000RT3U	156-276	208/240 & 120	6000/4200	Hardwire*	Hardwire*	Hardwire*	9U	26 in.	Internal/External
SU6000RT4U	65-140 (L-N)	208/240 & 120	6000/4200	12	8 (5-15/20R) 2 (L6-20R) 2 (L6-30R)	L14-30P	4U	30.75 in.	Internal/External
SU8000RT3U	156-276	208/240	8000/6400	6	4 (L6-20R) 2 (L6-30R)	Hardwire	6U	31.5 in.	Internal/External
SU8000RT3U1TF	156-276	208 & 120	7500/6000	18	12 (5-15/20R) 4 (L6-20R) 2 (L6-30R)	Hardwire	8U	31.5 in.	Internal/External
SU8000RT4U	65-140 (L-N)	208/240 & 120	8000/5600	8	Hardwire 4 (5-15/20R) 2 (L6-20R) 2 (L6-30R)	Hardwire	4U	34 in.	Internal/External
SU10000RT3U	156-276	208/240	10000/8000	6	4 (L6-20R) 2 (L6-30R)	Hardwire	6U	31.5 in.	Internal/External
SU10000RT3U2TF	156-276	208 & 120	10000/8000	30	24 (5-15/20R) 4 (L6-20R) 2 (L6-30R)	Hardwire	10U	31.5 in.	Internal/External
SU10KRT3U	156-276	208/240 & 120	10000/8000	Hardwire	Hardwire	Hardwire	9U	31.5 in.	Internal/External
SU16000RT4U	65-140 (L-N)	208/240 & 120	16000/11200	+13	Hardwire 5 (5-15/20R) 2 (L6-30R) 6 (C19)	Hardwire	8U	40.5 in.	Internal/External

** SU6000RT3U can provide outlets when used with optional back panel accessory (SUPDM12) which provides two L6-20R, one L6-30R and ten 5-20R outlets and a cord with a L6-30P input plug.*

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SmartPro® Line-Interactive UPS Systems									
Model	Input Voltage Range	Nominal Output Voltage	Capacity (VA/Watts)	Outlet Quantity	Outlet Type	Input Plug Type	RU	Depth	Bypass
SMART1500CRMXL	83-145	120	1500/1440	8	8 (5-15R)	5-15P	2U	19 in.	Internal
SMART2200RMXL2U	120	120	2200/1600	8	4 (5-15R) 4 (5-20R)	5-20P	2U	17 in.	None
SMART2200CRMXL	83-145	120	2200/1900	8	4 (5-15R)	5-20P	4U	16.75 in.	Internal
SMART3000RM2U	120	120	3000/2250	9	4 (5-15R) 4 (5-20R) 1 (L5-30R)	L5-30P	2U	17 in.	None
SMART3000CRMXL	83-145	120	3000/2880	9	8 (5-15R) 1 (L5-30R)	L5-30P	4U	16.75 in.	Internal
SMART5000XFMRXL	208	208 & 120	5000/3750	11	8 (5-20R) 2 (L6-20R) 1 (L6-30R)	L6-30P	3U	23 in.	None

UPS System Extended Runtime						
SmartOnline On-Line UPS Systems						
Half load (Watts) Full Load (Watts)	Runtime (minutes) with included batteries	Non-Expandable Battery Pack	1	Expandable Battery Pack* 2	 3	 4
SU2200RTXL2Ua Extended Runtime		BP48V24-2U (Non-Expandable)		BP48V60RT-3U (Expandable)		
800	14	56	117	266	378	530
1600	4.5	23	50	122	186	246
SU3000RTXL3UHV & SU3000RTXL3U Extended Runtime		BP72V15-2U (Non-Expandable)		BP72V28RT-3U (Expandable)		
1200	17	41	78	158	252	327
2400	6	17	33	69	108	150
SU5000RT3UHV & SU5000RT3U Extended Runtime				BP240V10RT-3U (Expandable)		
1750	20	N/A	73	161.6	225.8	291
3500	8	N/A	31	70	100	131
SU5000RT4U Extended Runtime						
1900	14	N/A	97.4	158.4	221.5	285.5
3800	6	N/A	42.5	70.7	100.7	131.7
SU6000RT3U Extended Runtime				BP240V10RT-3U (Expandable)		
2100	37	N/A	79	131	174	222
4200	15	N/A	37	58	79	104
SU6000RT4U Extended Runtime						
2100	24	N/A	86.6	141.4	198.2	256
4200	9	N/A	36.8	61.5	87.8	115.2
SU8000RT3U Extended Runtime				BP240V10RT-3U (Expandable)		
3200	15	N/A	46	76	109	142
6400	6	N/A	18	32	46	60
SU8000RT3U1TF Extended Runtime						
3200	15	N/A	46	76.4	108.7	142
6400	6	N/A	18.6	31.6	45.6	60.4
SU8000RT4U Extended Runtime				BP192V12-3U (Expandable)		
2800	12	N/A	47	100	141.1	183.8
5600	5	N/A	19	42.8	61.5	81.1
SU10KRT3U, SU10000RT3U, & SU10000RT3U2TF Extended Runtime				BP240V10RT-3U (Expandable)		
4000	10	N/A	35.1	58.6	83.8	110
8000	4	N/A	13.7	23.5	34.1	45.3
SU16000RT4U Extended Runtime				BP192V18-4U (Expandable)		
5600	12	N/A	42.2	70.2	100	130.9
11200	5	N/A	17.1	29.2	42.2	55.9

* Included batteries are contained either internally within the UPS system or are included as an external module, depending on model. ** Battery packs which are expandable can be connected together for increased runtime. Call Tripp Lite's Application Specialists at (773) 869-1236 for additional extended runtime solutions to fit your specific load requirements.

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SmartPro Line-Interactive UPS Systems						
Half load (Watts)	Runtime (minutes)	Non-Expandable Battery Pack	Expandable Battery Pack*			
Full Load (Watts)	with included batteries		1	2	3	4
SMART1500CRMXL Extended Runtime		BP48V24-2U (Non-Expandable)		BP48V48RT4U (Expandable)		
720	28.5	70.6	195.5	349.2	504.2	658.8
1440	11	28.1	82.1	152	225	299.3
SMART2200RMXL2U Extended Runtime		BP48V24-2U (Non-Expandable)		BP48V60RT-3U (Expandable)		
800	16	62	128	264.3	403.4	542.9
1540	6	24.5	52.6	113	177.3	243.5
SMART2200CRMXL Extended Runtime		BP48V24-2U (Non-Expandable)		BP48V48RT4U (Expandable)		
950	28.5	68.8	154	265.4	378.7	492.5
1900	11	27.7	64.5	114.8	167.7	222
SMART3000RM2U Extended Runtime		BP48V24-2U (Non-Expandable)		BP48V60RT-3U (Expandable)		
1120	21.2	59.9	124.3	256.2	391.5	527.2
1600	8.5	24.9	53.4	114.5	179.7	246.6
SMART3000CRMXL Extended Runtime		BP48V24-2U (Non-Expandable)		BP48V48RT4U (Expandable)		
1440	19	35.4	81.7	144.3	209.5	276
2880	7.5	14.7	35.2	63.8	94.5	126.4
SMART5000XFMRXL Extended Runtime				BP48V60RT-3U (Expandable)		
1875	27	N/A	63	117.9	175.8	235.2
3750	10	N/A	24.4	47	71.7	97.6

* Battery packs which are "expandable" can be connected together for increased runtime. Call Tripp Lite's Application Specialists at (773) 869-1236 for additional extended runtime solutions to fit your specific load requirements.

About the author: David Slotten is Director of Product Management at Tripp Lite. Mr. Slotten joined Tripp Lite in 1990 and has extensive experience in the sale, marketing, engineering and development of power protection systems. Mr. Slotten has an MBA from Lake Forest Graduate School of Management and a bachelor's degree from the University of Wisconsin.

For Additional VoIP and Internet Telephony Application Assistance Call Tripp Lite's Application Specialists at (773) 869-1236

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Tripp Lite's PowerAlert Software, version 12.5, has tested compatible with Cisco CallManager, versions 4.0 and 4.1, Cisco 7600 Series Routers, 7500 Series Routers and Catalyst 65XX Layer 3 Switch. Tripp Lite PowerAlert Software, version 12, has tested compatible with Cisco CallManager, versions 3.3(4)-MCS and 4.0(2)-MCS. The Cisco Compatible logo signifies that Tripp Lite's product has undergone interoperability testing by Tripp Lite together with Cisco and a third-party test house based on testing criteria set by Cisco. Tripp Lite is solely responsible for the support and warranty of its product. Cisco makes no warranties, express or implied, with respect to Tripp Lite's product or its inter-operation with the listed Cisco product(s) and disclaims any implied warranties of merchantability, fitness for a particular use or against infringement.

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